

360°

to be transmitted to the transmission shaft 21 is transmitted to one rotor shaft 12A via the gears 22 and 23c. The driving force of the rotor drive shaft 12A is transmitted to the other rotor drive shaft 12B via the gears 23a and 23b.

For assembling the rotary pump constructed as set forth above, the pumping segment 4 of each rotor 1A and 1B is received within the pumping chamber 7 of the main casing 10. In conjunction therewith, each rotor shaft 2 is engaged with the hollow portion 16a at the tip end of the hollow rotor drive shaft 12 supported within the gearbox 13. Then, the rotor fastening bolt 15 is inserted within the rotor drive shaft 12 from one end to threadingly engage the threaded portion 15b at the tip end thereof with the threaded bore 3 of the rotor shaft 2. Then, the bolt head 15a is rotated by a rotary tool, such as spanner or the like for tightening to draw each rotor 1A and 1B toward the rotor drive shaft 12 for fixedly fastening.

In the rotary pump assembled as set forth above, a rotational torque of the not shown motor is transmitted to the transmission shaft 21. Both of the rotor drive shafts 12 driven to rotate via the transmission shaft 21 drive to rotate both rotors 1A and 1B in mutually opposite directions in synchronism with respect to each other as shown by arrows in Fig. 11. Thus, by action of the pumping segments 4 rotated within the pumping chambers 7, liquid is sucked into the pumping chamber 7 through the suction port 8 and is pressurized and fed to the discharge port 9. In this case, overall inner side surface of the casing cover 11 is a flat surface forming in flush with the external end surface of the rotors 1A and 1B so as not to form recessed portion between the rotors 1A and 1B. Therefore, retention of the transported liquid flowing through the pumping chamber 7 will never be caused. Accordingly, washing of the pumping chamber can be easily performed.

On the other hand, upon disassembling the rotors 1A and 1B, the nuts 20 are loosen to remove the casing cover 11, and thereafter, the rotors 1A and 1B are disassembled easily by simply loosening the rotor fastening bolts 15.

As can be clear from the construction, in the prior art, the gearbox 16 for the transmission shaft 21 is provided separately from the gearbox 13 of the drive shaft, and driving force has to be transmitted to the rotor drive shaft 12 via the gear mounted on the transmission shaft 21 on the side of the motor and the gear 23a housed within the gearbox 13 for the drive shaft.

Conventionally, in addition to a pair of rotor drive shafts 12A and 12B for driving the rotor as set forth above, the transmission shaft 21 for transmitting the rotational torque of the motor to the rotor drive shafts 12A and 12B, and thus at least three shaft in total are required. Therefore, the construction is inherently complicate.

On the other hand, as can be clear from the construction set forth above, in the recent prior art, the rotor fastening bolt 15 inserted into the hollow portion of the hollow rotor drive shaft 12 is rotated by rotating the bolt head 15 at the rear end portion with the rotary tool in the condition where the threaded portion 15b at the tip end is threadingly engaged with the rotor 1A (1B) to draw the rotor 1A backward by the rotor fastening bolt 15 and to abut the bolt head 15a onto the end surface of the hollow rotor drive shaft 12. On the other hand, upon disassembling, the rotors 1A and 1B can be disassembled easily only by

00750" 033100

loosening the rotor fastening bolt 15 by rotatingly operating the bolt head 15a. Also, the mating surfaces of the rotor 1A(1B) and opposing casing cover 11 may be formed in flush. Coupling between the rotor 1A(1B) and the hollow rotor drive shaft 12A(12B) is effected by externally engaging the tip end portion of the drive shaft and by maintaining external engagement by drawing force applied by tightening the rotor fastening bolt 15 into the rotor shaft 12. Therefore, connection force therebetween is insufficient. Also, centering of the rotor 1A(1B) and the hollow rotor drive shaft 12A(12B) cannot be complete to possibly cause center vibration.

Furthermore, as shown in Figs. 10 and 11, the conventionally rotary pump defines the pumping chamber 7 with the main casing 10 and the casing cover 11 mounted thereon. A pair of rotors 1A and 1B are housed within the pumping chamber 7. The end surface 1a of the casing cover 11 of each of rotors 1A and 1B are placed in substantially contacting state with a minimum fine gap required for permitting rotation of the rotor 1A and 1B. Both rotors 1A and 1B are synchronously rotated in mutually opposite directions by mutually engaging the pumping segments 4 of the rotors 1A and 1B by the rotor drive shafts 12 as shown by the arrows of Fig. 11. Thus, the liquid is sucked into the pumping chamber 7 through the suction port 8, and pressurized and fed to the discharge port 9. In this case, a gap between the end surface 1a of each rotor 1A and 1B and the inner end surface 11a of the casing cover 11 mating thereto is substantially contacting state with minimum fine gap for permitting rotation of the rotor 1A and 1B. Flow ability of the liquid in this fine gap is quite low. Accordingly, even when the washing liquid is circulated within the pumping chamber at the end of work in one day, the washing liquid does not flow sufficiently between both end surfaces 11a and 1a. Therefore, sufficient washing effect cannot be achieved.

SUMMARY OF THE INVENTION

The present invention has been worked out in view of the problems set forth above. Therefore, it is the first object of the present invention to construct a rotary pump with simple construction by omitting a transmission shaft on the side of a motor and whereby to make a cost of the rotary pump as low as possible, with maintaining feature that assembling and disassembling is facilitated.

The second objection of the present invention is to enhance fastening force between the rotary drive shaft and the rotor and assure centering therebetween so as not to cause center vibration even by long term use.

The third object of the present invention is to achieve satisfactory washing effect by flowing sufficient amount of washing liquid through a gap between an end surface of a rotor and an inner end surface of a casing cover opposing thereto.

According to the first aspect of the present invention, a rotary pump comprises:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent

007E0' 66565656

the pump casing for integrally rotate with a pair of the rotors; and
a pair of rotor fastening bolts inserted into hollow portions of
respective hollow rotor drive shafts to fix the pair of rotors and the pair of
hollow rotor drive shafts on the outer end surfaces of the rotor drive shaft
under tension,

respective of the hollow rotor drive shafts being synchronously rotated
in mutually opposite direction with meshing with synchronous driving gears
provided in respective gearboxes,

among both of the hollow rotor drive shafts, one of the hollow rotor drive
shaft extends outwardly from the gearbox to form an extended drive shaft
portion, a cylindrical frame form transmission coupling having an operation
space for operating the rotor fastening bolt being coupled with the extended
drive shaft portion for integral rotation.

According to the second aspect of the present invention a rotary pump
comprises:

a pair of rotors having pumping segments mutually engaged with
each other for synchronous revolution in mutually opposite direction within a
pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent
the pump casing for integrally rotate with a pair of the rotors; and

a pair of rotor fastening bolts inserted into hollow portions of
respective hollow rotor drive shafts to fix the pair of rotors and the pair of
hollow rotor drive shafts on the outer end surfaces of the rotor drive shaft
under tension,

respective of the hollow rotor drive shafts being synchronously rotated
in mutually opposite direction with meshing with synchronous driving gears
provided in respective gearboxes,

the rotors and the hollow rotor drive shafts being connected by
spline couplings for integral rotation,

the rotor fastening bolts being inserted through the hollow rotor drive
shafts through the rotors from the side of the casing cover, and
a flange provided on a end portion of the rotor fastening bolt being
engaged within a recessed portion on the end surface of the rotor
on the side of the casing cover.

According to the third aspect of the present invention, a rotary pump
comprises:

a pair of rotors having pumping segments mutually engaged with
each other for synchronous revolution in mutually opposite direction within a
pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent
the pump casing for integrally rotate with a pair of the rotors; and

a pair of rotor fastening bolts inserted into hollow portions of
respective hollow rotor drive shafts to fix the pair of rotors and the pair of
hollow rotor drive shafts on the outer end surfaces of the rotor drive shaft
under tension,

respective of the hollow rotor drive shafts being synchronously rotated
in mutually opposite direction with meshing with synchronous driving gears

provided in respective gearboxes,

the rotor and the hollow rotor drive shaft being connected by spline coupling for integral rotation,

the rotor fastening bolts being integrally formed with the rotors, and the rotor fastening bolts being inserted into the hollow rotor driven shafts.

According to the fourth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

an air cylinder being mounted on the casing cover and having a piston rod, to which the cover piston is connected.

According to the fifth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

a lock cylinder having a lock bolt being mounted on the casing cover for restricting movement of the cover piston by means of the lock bolt.

According to the fifth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

an air cylinder being mounted on the casing cover and having a piston rod;

a lock cylinder having a lock bolt being mounted on the air cylinder;

the cover piston being connected to a piston rod projected from one end

surface of the piston of the air cylinder;

a piston rod projecting from the other end surface of the piston of the air cylinder being abutted to the lock bolt for restricting movement of the cover piston by means of the lock bolt.

According to the sixth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

a plurality of air cylinders being mounted on the casing cover in a condition where piston rods thereof are connected with each other, and the cover piston is connected to a piston rod.

and having a piston rod, to which the cover piston is connected.

According to the seventh aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

a plurality of air cylinders being mounted on the casing cover in a condition where piston rods thereof are connected with each other, and the cover piston is connected to a piston rod.

and having a piston rod, to which the cover piston is connected;

a lock bolt being coaxially provided on the air cylinder at the rearmost position, and the cover piston being connected to the piston rod of the air cylinder at the most front side;

a piston or a piston rod of the air cylinder at the rearmost position being in contact with the lock bolt for restricting movement of the cover piston by the lock bolt.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given hereinafter with reference to the accompanying drawings of the preferred embodiment of the present invention, which, however, should not be taken to be limitative to the present invention, but are for explanation and understanding only.

In the drawings:

Fig. 1 is a partially sectioned front elevation of one embodiment of a rotary pump according to the present invention;

Fig. 2 is a perspective view of the major part of the first embodiment of the rotary pump;

Fig. 3 is a longitudinally sectioned front elevation of another major part of the first embodiment of the rotary pump;

Fig. 4 is a longitudinally sectioned front elevation of another embodiment of the portion shown in Fig. 3;

Fig. 5 is a partially sectioned front elevation of another embodiment of the rotor according to the present invention;

Fig. 6 is a partially sectioned front elevation of slightly modification of the embodiment shown in Fig. 5;

Fig. 7 is a longitudinally sectioned front elevation showing operating condition of the major part of the embodiment shown in Fig. 5;

Fig. 8 is a longitudinally sectioned front elevation showing operating condition of the major part of the embodiment shown in Fig. 6;

Fig. 9 is a longitudinally sectioned front elevation showing operating condition of the major part of another embodiment shown in Fig. 6;

Fig. 10 is a partially sectioned front elevation of the conventional rotary pump; and

Fig. 11 is a side elevation of an internal mechanism.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be discussed hereinafter in detail in terms of the preferred embodiment of the present invention with reference to the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be obvious, however, to those skilled in the art that the present invention may be practiced without these specific details. In other instance, well-known structure are not shown in detail in order to avoid unnecessary obscurity of the present invention.

Fig. 1 shows one embodiment of a rotary pump according to the present invention. A construction of the rotary pump is basically the same as the prior art shown in Figs. 10 and 11. Namely, a pump casing 30 is constructed with a main casing 43 which define a concave pumping chamber 42 one the side of one end surface for housing a pair of rotors 31A and 31B (which will be identified by the reference numeral 31 as generally referred to) and loosely engage with pumping segments 32 which are integrally formed with the rotors 31A and 31B for rotation therein, and also defines a suction port 50 and a discharge port 51 communicated with the pumping chamber 42, and a casing cover 44 detachably mounted on the main casing 43 by bolts 52 in flush with the end surface of a pair of rotors 31.

It is similar to the prior art in that a pair of rotors 31 are mounted on hollow rotary drive shafts 34A and 34B (which will be identified by reference numeral 34 as generally referred to) by tightening rotor fastening bolt 36 into hollow portions 35 of the rotary drive shafts 34. However, particular mounting structure is differentiated from the prior art. As shown in Fig. 3, in accordance with the present invention, a through opening 53 formed with an internal

hollow rotor drive shaft 34A is extended from the gearbox 33 in greater extent to form an extended drive shaft portion 39. On the extended drive shaft portion 39, a cylindrical frame shaped transmission coupling 42 which is important feature of the present invention, is connected.

Namely, as shown in Fig. 2, the transmission coupling 42 is formed with a cylindrical frame shaped coupling body 59 having a large operation window 58 on the circumference thereof, a boss hole projected on one end surface for connection, a connecting frame 62 for connecting a coupling 61 on the side of the other end portion of the transmission member, an operation window 63 and a connecting hole 64. After appropriately fitting a collar 65 to the extended drive shaft portion 39, the extended drive shaft 39 is engaged with the connecting boss hole 60 of the transmission coupling 41 to establish a key coupling with a key groove 66 and a key 67 provided between the extended drive shaft 39 and the transmission coupling 41. Furthermore, on a threaded portion 39a provided on the outer periphery of the extended drive shaft 39, a connecting nut 68 is engaged and tightened for coupling the extended drive shaft portion 39, and namely the hollow rotor drive shaft 34 with the transmission coupling 41 for integral rotation. On the other hand, a transmission member 69 connected on the side of the motor is connected to the transmission coupling 41 via the coupling 61 on the side of the transmission member by bolt and nut 70, the connecting hole 64 of the connecting frame 62 engaged with the bolt and nut 70 and a buffering connecting member 71 engaged with the connecting hole 64. As can be clear from the discussion given hereabove, the foregoing fastening nut 49 and the lock nut 57 are tightened with the rotor fastening body 36 after mounting the transmission coupling 41, as a matter of course.

Upon driving the rotary pump constructed as set forth above, a rotational force of the transmission member 69 connected on the side of the motor is transmitted to the transmission coupling 41 via the coupling 61 on the side of the transmission member. The coupling 41 drives the hollow rotor drive shaft 34A on one side which is connected directly to the coupling 41, and drives the other hollow rotor drive shaft 34B via a pair of synchronous driving gears 37 and 38. By this, a pair of rotors 31 are synchronously rotated in mutually opposite directions.

During rotation of the rotors, since the main casing 43 and the casing cover 44 are firmly fitted with each other in face-to-face contact, the transported liquid may not be retained in this portion to keep the rotary motor in sanitary state. Upon disassembling, in the condition where the transmission coupling 41 is mounted on the hollow rotor drive shaft 34, an operator may insert a rotary tool, such as spanner, screw driver or the like into an operation space 40 through the operation window 58 or 63 to easily disengage the fastening nut 49 and the lock nut 57 which are engaged with the rotor fastening bolt 36 within the operation space 40. Then, by loosening the bolt and nut 20, the casing cover 44 is disassembled from the main casing 43. Thus, the rotor 31 and the rotor fastening bolt 36 as assembled or integrated as in the embodiment shown in Fig. 4 may be withdrawn to the outside of the main casing 43. Therefore, the pumping chamber 42 can be easily disassembled

for performing cleaning operation.

Upon assembling, the rotor drive shaft 34 is inserted into the through opening 53 in such a manner that the spline shaft 45 of the rotor drive shaft 34 is engaged with spline surface of the rotor 31. The rotor fastening bolt 36 is then inserted into the hollow portion 35 of the hollow rotor drive shaft 34 from the side of the casing cover 44. At the rear end portion, the operator tightens the fastening nut (washer) 49 and the lock nut 57 (fastening nut) onto the rotor fastening bolt 36 within the operation space 40 through the operation window 58 or 63. Thus, the rotary pump can be easily assembled.

With the foregoing embodiment, the spline shaft 45 at the tip end portion of the hollow rotor drive shaft is engaged with the spline surface on the inner periphery of the through opening 53 of the rotor 31, and the hollow rotor drive shaft 34 and the rotor 31 are rigidly secured with each other by the rotor fastening bolt 36. Therefore, slip will never be caused therebetween to assure integral rotation. Furthermore, concentric relationship between the rotor and the hollow rotor drive shaft can be maintained for a long period.

Figs. 5 to 9 show another embodiment of the rotary pump according to the present invention. It should be noted that, in the following disclosure, components common to the former embodiment of Figs. 1 to 4, will be identified by the same reference numerals, and detailed discussion for such common components will be omitted in order to avoid redundant discussion and whereby to keep the disclosure simple enough to facilitate clear understanding of the present invention. Therefore, the following disclosure will be concentrated to the particular construction of the shown embodiment.

As shown in Fig. 5, a space 80 having a given width in a thickness direction of a casing cover 44A is defined at the center portion of the casing cover 44A with the end surface 31a of the rotor 31 by forming a recess on the surface of the casing cover 44A mating with the end surface 31a of the rotor 31. A cover piston 81 is engaged with the peripheral wall defining the space 80 in gas tight fashion for reciprocal motion in the thickness direction, namely toward and away from the end surface 31a of the rotor 31. An air cylinder 82 is mounted on the casing cover 44A in coaxial relationship with the cover piston 81 by mounting bolts 83. The air cylinder 82 is constructed with a cylinder body 82a, a cylinder cover 86 located on the side of the casing cover 44A, a cylinder cover 87 on the opposite side, a piston 88 slidably reciprocating within the cylinder body 82a, a piston rods 83a and 83b (which will be identified by reference numeral 83 as generally referred to) extending from both sides of the piston 88, and inlet and outlet ports 89 and 90 communicated with forward drive side and reverse drive side cylinder chambers 89 and 90 defined on both sides of the piston 88. The cylinder cover 86 on the side of the casing cover 44A may be formed to be common with the casing cover 44A. Also, the cylinder cover 86 may be provided separately on the side of the air cylinder 82. In this case, the space 80 of the casing cover 44A is formed through the casing cover 44A. On the other hand, the cylinder cover 86 formed separately on the side of the air cylinder 82 may serve as the casing cover 44A and the cylinder cover 86 and the casing cover may be formed integrally with each other. In this case, the cylinder cover 86 of the air cylinder is mounted directly on the main

casing 43 as the casing cover 44A by the bolts.

The end surface 81a on the side of the rotor 31 of the cover piston 8 is mated with the inner end surface 44a of the casing cover 44A for tight fitting with each other. On the other hand, the end surface 81a of the rotor 31 is substantially in contact with the end surface 31a of the rotor 31 with maintaining a fine gap therebetween. The piston rod 83a extended from the piston 88 of the air cylinder 82 toward the casing cover 44A is integrally connected to the cover piston 81 through the cylinder cover 86. The piston rod 83b projecting from the piston toward the opposite side is extended externally through the other cylinder cover 87. More accurately, the piston rod 83b is formed with a collar 94 engaging with a small diameter portion 93 and a nut 95 threadingly engaged with a thread portion at the tip end of the small diameter portion in order to secure the collar 94.

To the air cylinder 82, a lock cylinder 85 is coaxially mounted as shown in Fig. 5. To the lock cylinder 83, a lock bolt 84 is threadingly engaged, which lock bolt may abut against a tip end surface of the piston rod 83b of the air cylinder 82 and is movable back and forth along motion direction of the piston rod 83b. On the lock bolt 84, a lock nut 46 is threadingly engaged for locking the lock bolt 84 at a predetermined position. The lock cylinder 85 is not limited to the cylindrical shape but can be any appropriate shape. Namely, the lock cylinder is only required to be any appropriate shape of the frame body, to which the lock bolt 84 is threadingly engaged for linear motion in back and forth direction. On the other hand, while the shown embodiment employs the piston rod 83b of the air cylinder to extend outwardly through the cylinder cover 87, it is also possible to engage the lock bolt 84 with the cylinder chamber 89 from the cylinder cover 87 to abut the tip end portion of the lock bolt onto the piston 88 instead of providing the piston rod 83b.

Fig. 6 shows a modification of another embodiment of the rotary pump, in which shape of the cover piston 81A to be engaged with the space 80 in gas tight fashion. In the embodiment shown in Fig. 5, an end surface 81a at one side of the rotor of the cover piston 81. In contrast to this, the present invention shown in Fig. 6 has the cover piston 81A, in which a head portion 99a of the bolt 99 is projected from the rotor 31. Therefore, a recessed portion 100 is provided for, in which a head portion 99a of the bolt 99 is projected from the rotor 31. Therefore, a recessed portion 100 is provided for receiving the head portion 99a of the bolt 99. In the shown construction of the rotary pump, a rotor drive shaft 117 is engaged at the center portion of the rotor 21 for mounting the rotor 31 on the rotor drive shaft 117. Across a stopper plate 101, the bolt 99 is threadingly engaged with the threaded hole 102 provided on the end surface of the rotor drive shaft 117. Thus, the rotor 31 is mounted on the rotor drive shaft.

Except for the shape of the cover piston 81, the shown modification has the same construction as the former embodiment. The common components has been omitted from the detailed discussion in order to avoid redundant discussion and whereby to keep the disclosure simple enough to facilitate clear understanding of the present invention.

With the construction set forth above, upon operating the rotary pump in

directly secure the lock cylinder 85 onto the casing cover 44 by means of bolts to abut the lock bolt 84 of the lock cylinder 85 to the portion projecting from the casing cover 44 (rod portion 83a).

Then, upon washing, the lock bolt 84 is retracted from the tip end surface of the piston rod 83b. At this condition, the washing water is fed into the pumping chamber to push the cover piston 81 away from the end surface 31a of the rotor 31 by the water pressure to form the large gap 104 therebetween to effectively flow large amount of washing waster to improve washing effect.

On the other hand, as set forth above, by retracting the lock bolt 84 of the lock cylinder 85 away from the tip end surface of the piston rod 83b on the right side of the air cylinder in the drawing, it becomes possible to provide vented (relief) cover function for the cover pistons 81 and 81A so that the pump discharge pressure of the rotary pump can be adjusted so as not to be elevated beyond a given pressure during automatic operation by the air cylinder.

Namely, by constantly supplying a given pressure of air through the inlet port 91 of the air cylinder 82, the cover pistons 81 and 81A are placed in opposition to the pumping action position of the end surface 31a of the rotor 31 by the piston 88 biased by the air pressure. When the discharge pressure of the pump is elevated beyond the given pressure to build up a pressure to retract the cover pistons 81 and 81A away from the end surface 31a of the rotor 31 overcoming the biasing pressure of the piston 88, the cover piston 81 is retracted from the end surface 31a of the rotor 31 to lower pumping function and relieve the discharge pressure. By this, the discharge pressure of the rotary pump can be regulated. The discharge pressure can be freely set by the air pressure to be supplied into the air cylinder.

Fig. 9 shows a further embodiment of the rotary pump according to the present invention. In the former embodiment, only one air cylinder 82 is provided. In contrast to this, the shown embodiment is provided with another air cylinder 82A mounted by bolts 105, in addition to the air cylinder 82. Respective pistons 36 and 106 are connected to piston rod 108 extending through a common cylinder cover 107. The lock bolt 84 is threadingly engaged with the cylinder cover 109 of the later air cylinder 82. In the shown embodiment, two air cylinders 82 and 82A are connected with each other. However, more than two air cylinders may be employed. On the other hand, in the shown embodiment, the lock bolt 84 is threadingly engaged with the rearmost air cylinder 82A. However, it is also possible to mount the air cylinder 82A at the rearmost position, to threadingly engage the lock bolt 84 and to contact the lock bolt onto the piston or the piston rod as shown in Figs. 5 and 6.

In the shown embodiment, by introducing air from an inlet portion 110 of the later air cylinder 82A into the forward side cylinder chamber 111 under pressure, the air is supplied to the forward side cylinder 89 of another air cylinder through a through hole 111\2 provided in the piston rod 108 to push the pistons 88 and 106 of both air cylinders 82 and 82A simultaneously. Therefore, the cover pistons 81 and 81A are held by both pistons 88 and 106 to maintain the cover pistons 81 and 81A at the position opposing to the

pumping action position of the end surface 31a of the rotor 31 at greater force. At this time, as discussed above, the color piston 81 and 81A are held at predetermined action position by the lock bolt 84 as required. The reference numerals 113 and 114 denotes inlet and outlet ports provided in reverse side cylinder chambers 90 and 115 of both air cylinders 82 and 82A, and the reference numeral 116 may be a ventilation aperture provided in the space 80.

Although the present invention has been illustrated and described with respect to exemplary embodiments thereof, it should be understood by those skilled in the art that the foregoing and various changes, emission and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to include all possible embodiments which can be embodied within a scope encompassed and equivalent thereof with respect to the feature set out in the appended claims.